Status of VEP analyses

Simona Rolli
Tufts University

VEP analyses

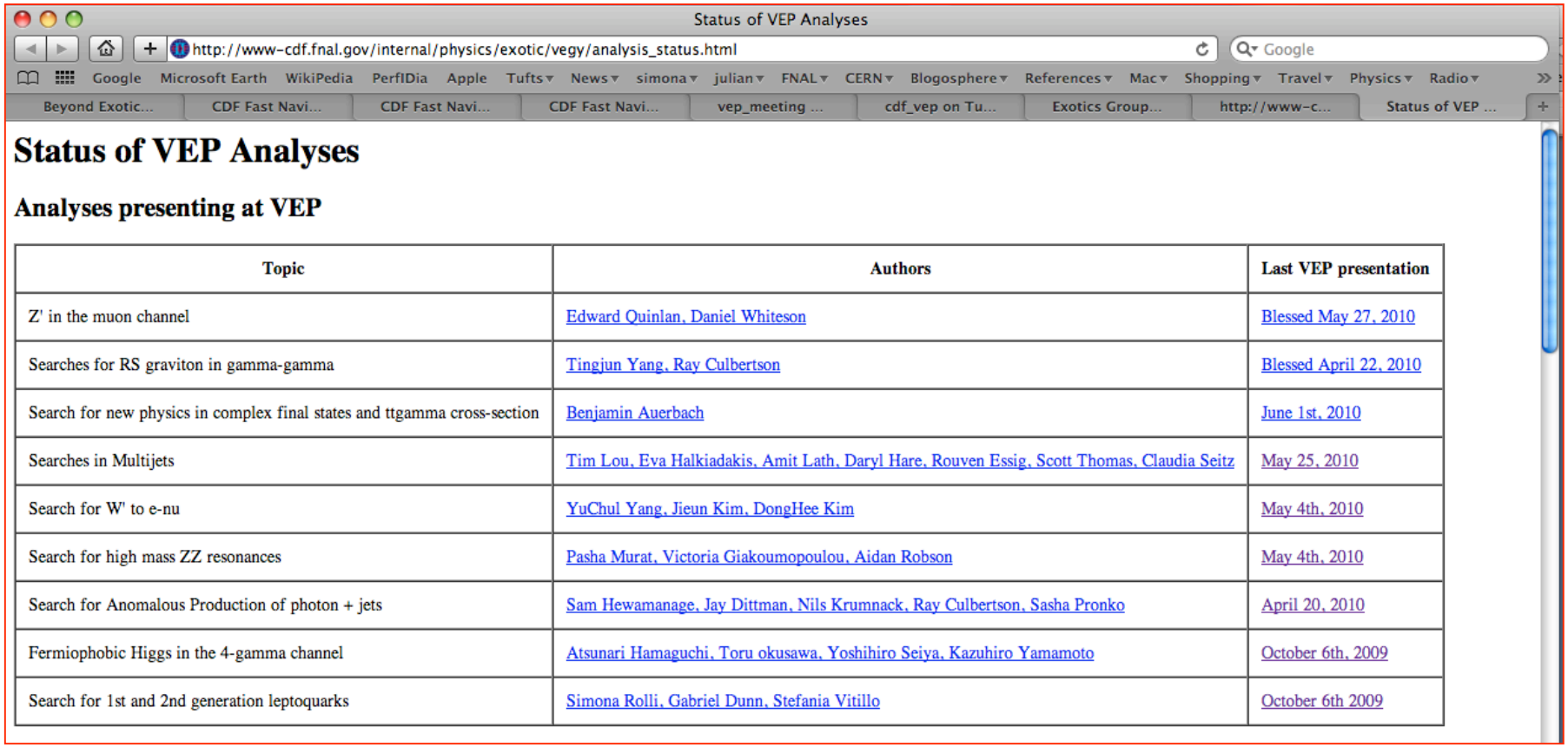
The VEP group is very active!

VEP is a working group:

prepare analyses to proceed to Exotic forum for blessing. The details needs to be solved in the VEP group;

- regular meetings every on-week, Tue 1.30PM, trailer 163-G
- since last time:
  - 2 analyses blessed, 1 just started blessing process
  - 2 new analyses/groups added
  - 6 analyses ongoing

VEP analyses



Status of VEP Analyses

Analyses presenting at VEP

Topic	Authors	Last VEP presentation
Z' in the muon channel	Edward Quinlan, Daniel Whiteson	Blessed May 27, 2010
Searches for RS graviton in gamma-gamma	Tingjun Yang, Ray Culbertson	Blessed April 22, 2010
Search for new physics in complex final states and ttgamma cross-section	Benjamin Auerbach	June 1st, 2010
Searches in Multijets	Tim Lou, Eva Halkiadakis, Amit Lath, Daryl Hare, Rouven Essig, Scott Thomas, Claudia Seitz	May 25, 2010
Search for W' to e-nu	YuChul Yang, Jieun Kim, DongHee Kim	May 4th, 2010
Search for high mass ZZ resonances	Pasha Murat, Victoria Giakoumopoulou, Aidan Robson	May 4th, 2010
Search for Anomalous Production of photon + jets	Sam Hewamanage, Jay Dittman, Nils Krumnack, Ray Culbertson, Sasha Pronko	April 20, 2010
Fermiophobic Higgs in the 4-gamma channel	Atsunari Hamaguchi, Toru okusawa, Yoshihiro Seiya, Kazuhiro Yamamoto	October 6th, 2009
Search for 1st and 2nd generation leptoquarks	Simona Rolli, Gabriel Dunn, Stefania Vitillo	October 6th 2009

Search for Z' into μμ

Previous searches for Z' used a template method to fit the mass spectrum in the hypothesis of an extra gauge boson.

Daniel Whiteson & Eddie Quinlan (UC Irvine)
Kyle Cranmer (NYU)

This analysis uses a matrix element method.

A per-event probability is calculated by convoluting LO matrix elements with functions describing the detector resolution (transfer functions)

$$P(\vec{x}|M) = \int P(\vec{x}|\vec{y})P(\vec{y}|M)\ \mathrm{d}\vec{y}$$

Transfer function $$T(\Omega; A_i, \mu_i, \sigma_i) = \sum_{i=1}^{3} A_i \exp\left(-\frac{(\Omega-\mu_i)^2}{2\sigma_i^2}\right)$$

Simulated muons are use to calculate Ω

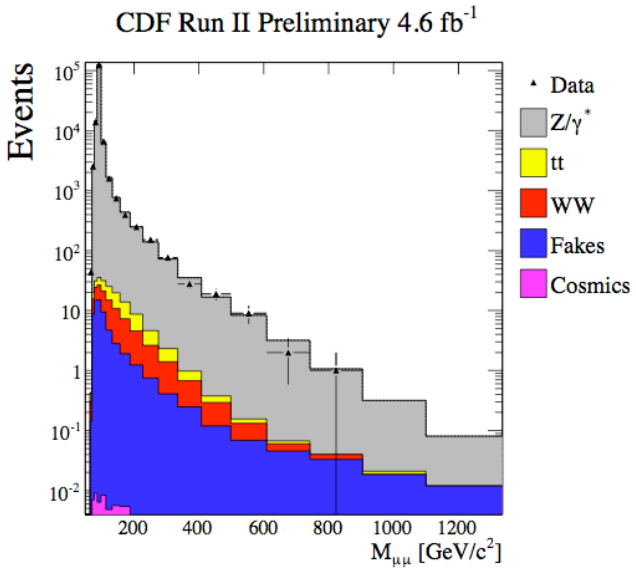
where $$\Omega(\vec{x}_{true}, \vec{x}_{meas}) = \frac{(p_T^{true})^{-1} - (p_T^{meas})^{-1}}{\delta_p}$$

As opposed to template method the ME method uses the information on the detector resolution event by event (some events are better measured than other)

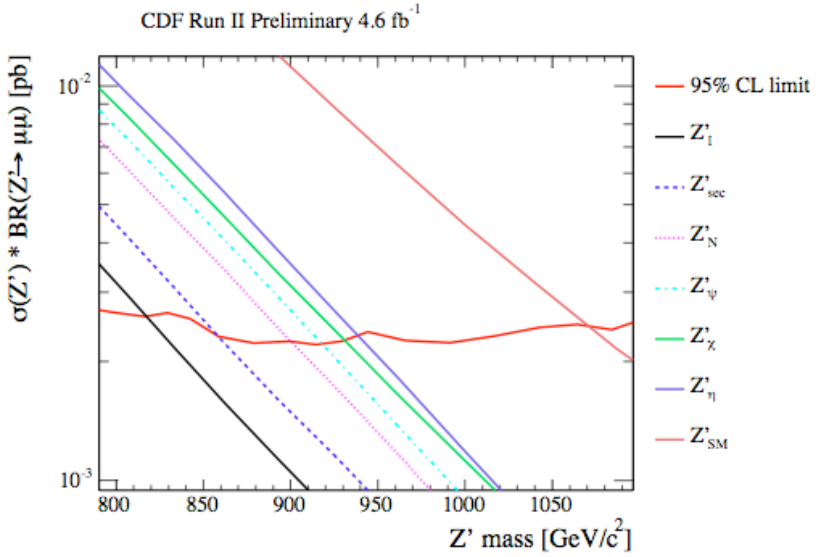
Z' into μμ

Source	$M_{\mu\mu} \in [70, 110]$	$M_{\mu\mu} \in [110, 130]$	$M_{\mu\mu} > 130$
Z/γ^*	146498.4	1903.6 ± 190	1797.0 ± 90.0
WW	38.0 ± 3.8	11.1 ± 0.5	21.6 ± 1.1
$t\bar{t}$	28.1 ± 2.8	11.2 ± 0.6	24.0 ± 1.2
MisID	46.6 ± 2.4	5.7 ± 0.2	8.1 ± 0.4
Cosmics	0.7 ± 0.02	0.1 ± 0.01	0.05 ± 0.01
Total	146611	1932 ± 192.0	1850.7 ± 90
Data	146382	1982	1813

4.6fb^{-1}



Blessed May 27



Model	Mass Limit (GeV/c^2)
Z'_I	817
Z'_{sec}	858
Z'_N	900
Z'_ψ	917
Z'_χ	930
Z'_η	938
Z'_{SM}	1071

Search for W' into νe

In various extension of the SM
extra gauge bosons are predicted

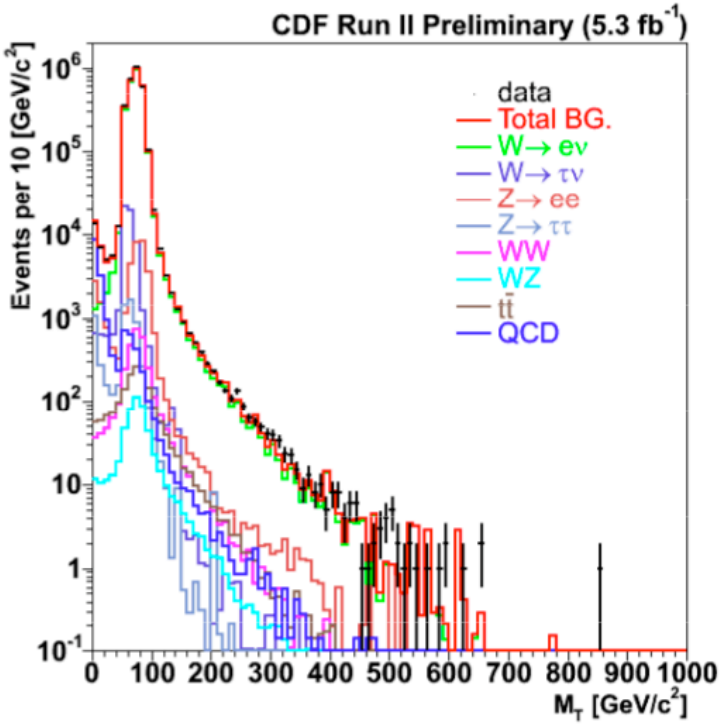
Yuchul Yang, Jieun Kim, DongHee Kim
(Kyungpook National Univerisy)

Event signature similar to $W \rightarrow e\nu$

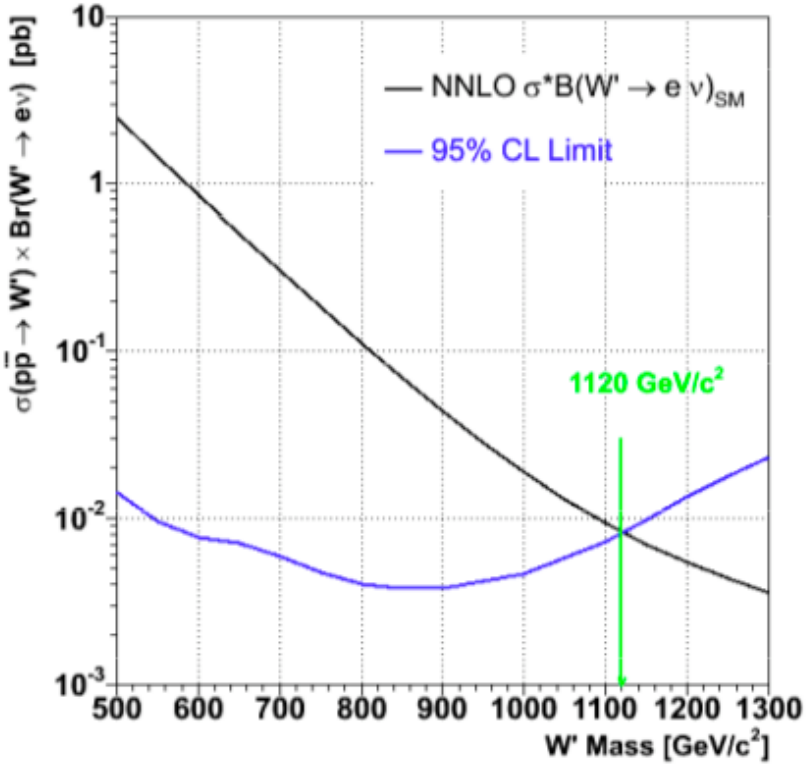
Look for excess in the "electron neutrino" transverse mass distribution over standard model expectation.

Background:

- $W \rightarrow e\nu$
- $W \rightarrow \tau\nu \rightarrow e\nu\nu\nu$
- $Z \rightarrow ee$
- $Z \rightarrow \tau\tau$
- $Diboson \quad (WW, WZ)$
- $t\bar{t}$
- $QCD \rightarrow misID \quad with \quad e, \; met$



W' into νe: preliminary limit



Current limit: 1TeV (D0)

To Do:

- Systematic Uncertainties
  - Jet Energy Scale
  - QCD Multijet : Anti-Electron Method
  - Electron Energy Scale
  - Parton Density Function
  - Initial State Radiation
  - Relative Fraction of Background

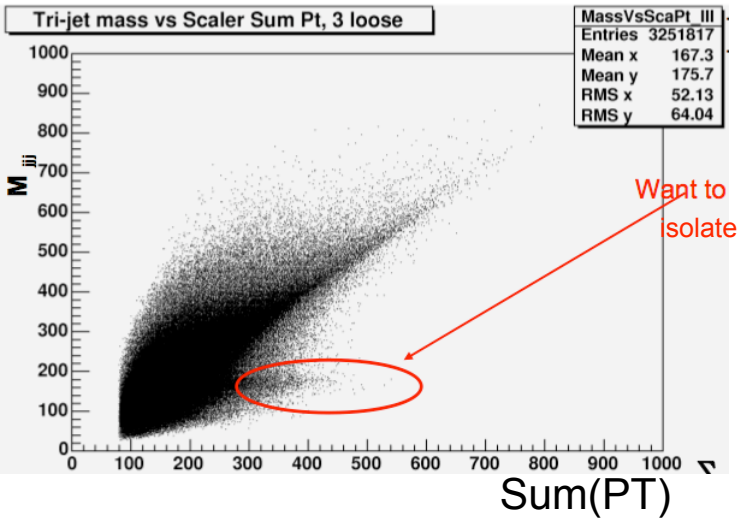
Search for resonances in multijets

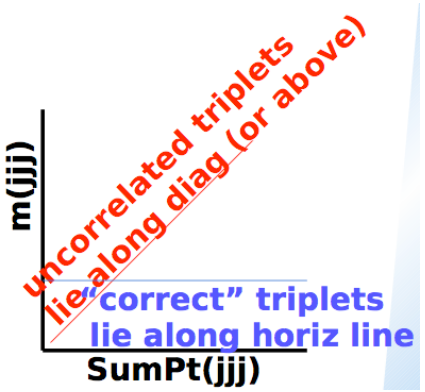
An interesting way to look for new physics in multijet !

Studying pp → QQ → 3j+3j = 6j

Eva Halkiadakis
Amit Lath, Daryl Hare, Claudia Seitz (Masters Student),
Tim Lou, Gautam Jain
(with theorist Scott Thomas)
Rutgers, the State University of NJ

Basic idea: plot M(jjj) vs Sum(P_T(jjj)) for all triplets





Diagonal Cut

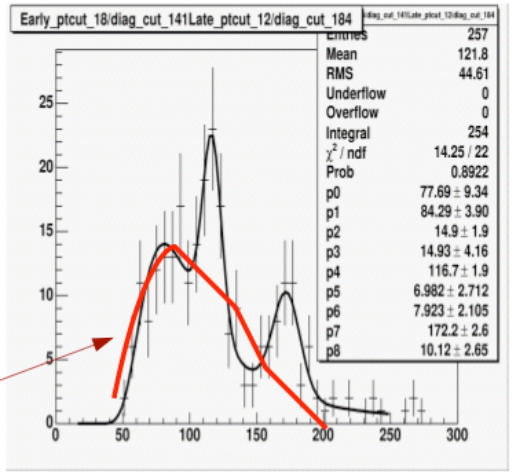
$M_{jjj} < \sum|p_{T,j}| - \text{offset}$

Lots of work since last time:

- Event selection finalized
- Background procedure (njet ≥ 5 jets sample used)
- Top MC discrepancy understood
- Cut optimization based on signal vs background expectations
- Analysis now focus on gluino production

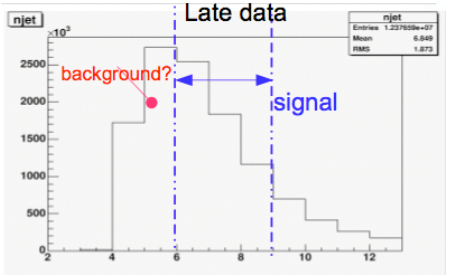
Multijets resonances:background

- Our problem is that we have no appropriate background MC.
  - ALPGEN 6-parton takes forever to generate.
- What happens when you fit SIGNAL (gaussians) and BACKGROUND (landaus) at the same time?
  - Horrible things: fluctuation can drive down background.
  - Fitter is happy, but results are misleading.
- Need independent, ***data-driven*** background estimate!



We are using Njet>=6 for signal.

How about Njet==5? for background?



First, we make the 5J Pt distribution match the Signal (6+ jet) dist. by weighting in SumPt.
Then we fit the *weighted* 5J mass and extract the Landau parameters,

Fit works!

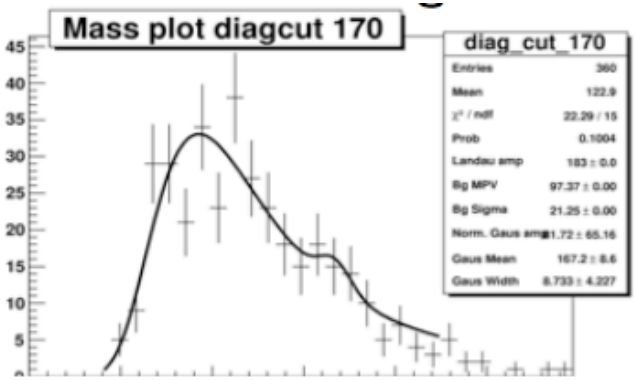
Multijets resonances:top

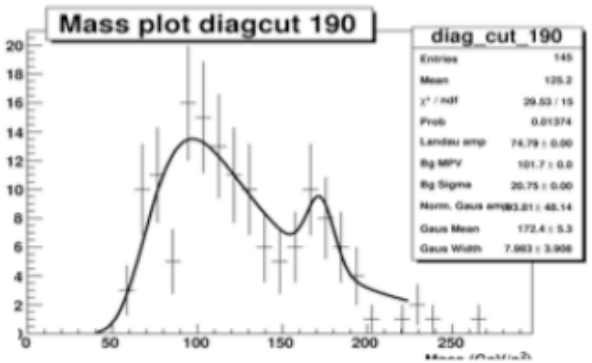
Resolved: Discrepancy with top MC

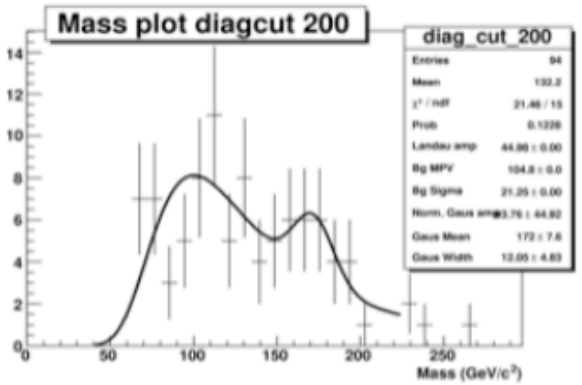
Recall from last time:
Gaussian fit to data in top peak gave: 10 ± 5 events (see previous slide)
MC prediction gave:
ttop75+otop49: 1.5 ± 0.1 (pythia 175)
dtopa5,6: 0.024 ± 0.025 (alpgen 172.5)

After extensive studies, we discovered that we were not using the "jet decoder" tool to select the proper jet collection in *newer* versions of TopNtuples.

Therefore, for some MC samples we were selecting cone 0.7 jets instead of cone 0.4 jets!





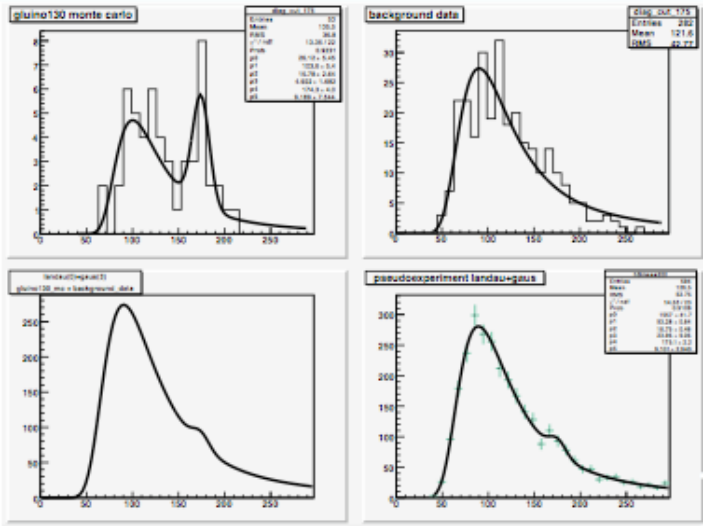


Multijet resonances: search for gluinos

Generated RPV gluinos pair produced

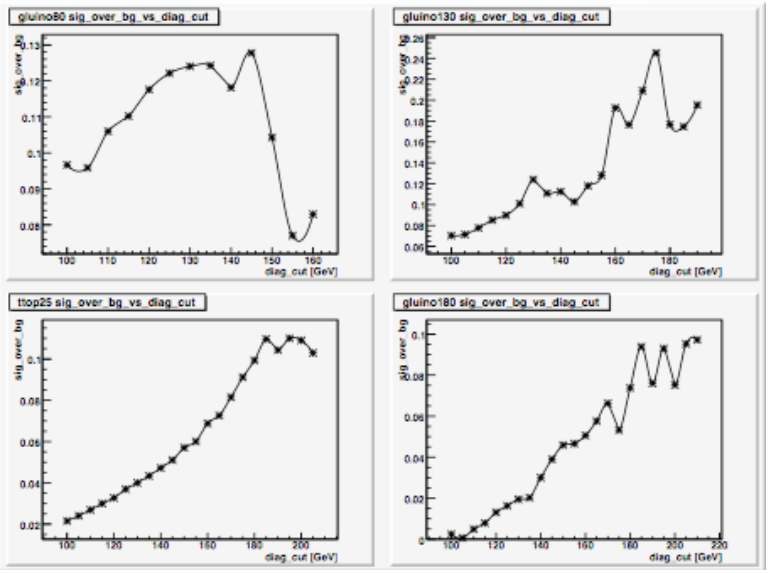
Signal/Background optimized using PE for each gluino mass point+background (from ≥ 5 jets weighted data) and for various diagonal cuts

Diagonal cut optimized



From left to right, top to bottom:

- Parent signal distribution with gaussian+landau fit
- Parent bkg (5J weighted) distribution with landau fit
- Combined fit from which we throw PSE
- Example PSE



On track for blessing:
-Expected limits vs mass
-Systematics

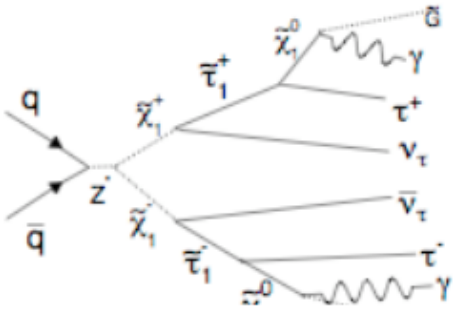
Full Status this week

Search for anomalous events in γ+Jet

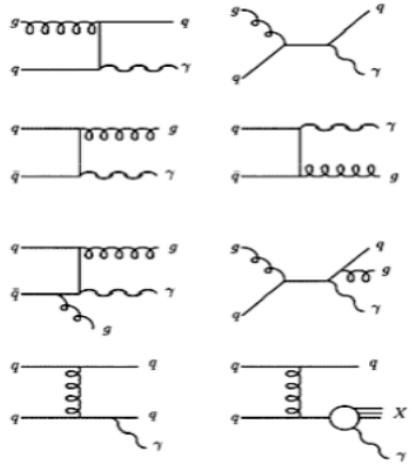
Sam Hewamanage, Jay Dittmann, Nils Krumnack
Baylor University

Ray Culbertson, Sasha Pronko
Fermilab

Various processes can give rise to anomalous production of γ+Jet



Various SM processes also contribute!



Searching for an excess (shape discrepancy) over the background predictions which will indicate new physics.

Scan kinematic plots photon E_T, invariant mass of photon and jet/s, missing transverse energy etc. for an excess.

Event Selection

- Require at least one of the three triggers
  - PHOTON_25ISO, 50 and 70
- Must be in good run list (v19_pho)
- >=1 Class 12 vertices
- z < 60 cm
- Photon + >=1 Jet

Jet Selection

- Cone size =0.4, JetClu
- Remove only the photon from jet list
- Corrected up to level 6 (UE), particle jet
- Require one or more jets with Et >15 GeV
- Can be in Central or plug (EvtEta<3.0)

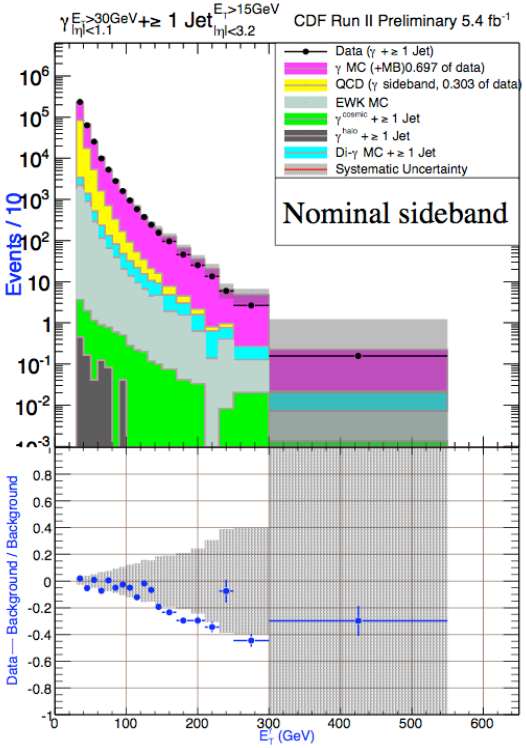
This analysis was previously blessed with 2 fb-1 of data
Updating now with 5.4fb^{-1}

Anomalous γ+jet

- We have looked at kinematics of photon+>=1 Jet and photon+>=2 jets events and found perfect agreements with SM.
- So far no evidence of BSM physics.
- Update with P26 data, 5.4 fb^{-1}. No unexpected behaviors observed. All background models are well behaved.
- Developed an additional more data-driven method. In this method, photon sideband is reweighted according to the photon E_T to the total background prediction. This reweighted sideband accounts for the missing NLO effects in the photon MC which directly affects jet E_T, NJet and H_T.
- This method gives consistent background predictions with the first method.
- First attempt of bump hunting is done using simple fit to the data and and a X^2 test.
- Tests are done to better understand MET distribution.
- Ready for blessing

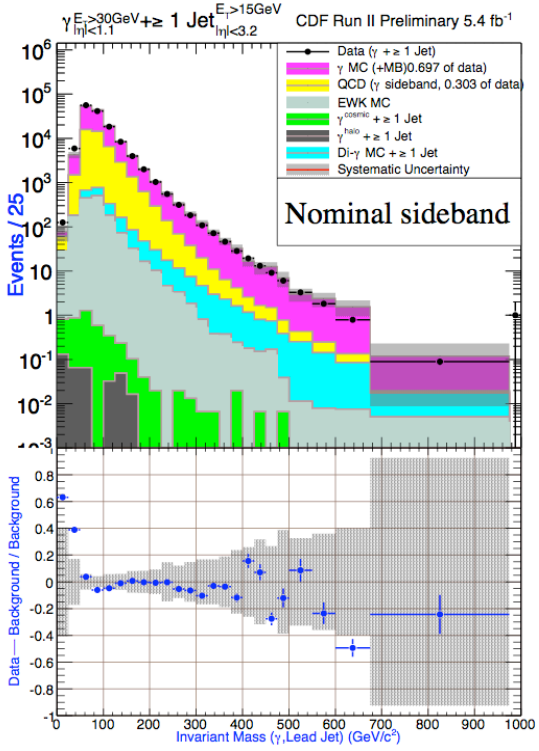
For Int. Lum=5.4 fb^{-1}	Photon + ≥1 Jet	Photon + ≥2 Jets
SM Photon (Photon MC)	2,369,900	616,555
QCD (Photon sideband)	1,030,243	231,526
EWK (EWK MC)	36,525	7963
Di-photon MC	22,358	4509
Cosmic (data-based)	100	6
Beam Halo (data-based)	9	1
PMT Spikes	0	0

Anomalous jet +γ



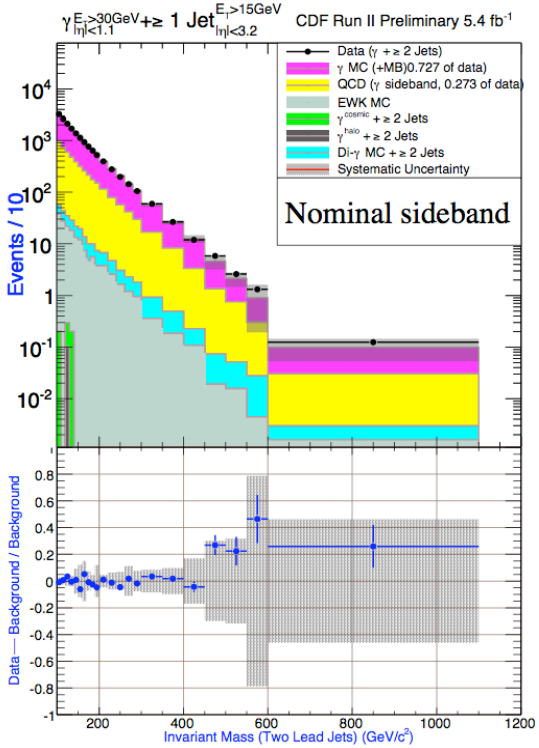
Photon E_T

photon+>=1 jet



Invariant Mass(Photon, Lead Jet)

photon+>=1 jet



Di-jet Mass

photon+>=2 jets

Searches for resonances decaying into ZZ

- studies of the final states with 2 heavy bosons is one of the focal points of the Tevatron analyses
  - search for the associative VH production
  - searches for new high mass resonance states with different spins
- Z is the heaviest vector boson, the easiest to identify via leptonic decays
- final states, corresponding to different Z decays, can be analysed together
  - $ZZ \rightarrow l^+l^-l^+l^-$
  - $ZZ \rightarrow l^+l^- + \nu\nu$
  - $ZZ \rightarrow l^+l^- + jj$

V.Giakoumopoulou [2], N.Giokaris [2], **P.Murat** [1], A.Robson [3]

[1]Fermilab [2]Univ of Athens [3]Univ of Glasgow

NEW!

Analysis Strategy:

•Use $M_{ZZ} < 300$ as a control region to measure the ZZ production cross-section

•$M_{ZZ} > 300$: search region

- consider 3 final states: 4l, 2l2j and 2l$\not\!\!E_T$
  - 4l channel: in hope to reconstruct more forward leptons strip loose 3+ lepton candidates (500K events), reprocess with GEN7
    - ★ did it once, will do one more time
    - ★ disabled Backward tracking
    - ★ one more pass of IO tracking fed by Phoenix electrons
  - 2l2j and 2l$\not\!\!E_T$ channels : use GEN6 [st]ntuples
- bless analysis with the data up to p26
- add p27 (5.3fb^{-1}), rebless for the summer conferences

ZZ resonances:status

Careful (re)consideration of several lepton ID cuts

- including the Tower 9 of the CEM
- including plug electrons in $1.13 < |\eta_{PES}| < 1.2$.

These electrons are excluded by the standard cuts but if proven reliable could increase the acceptance for the 4e channel by ~40%

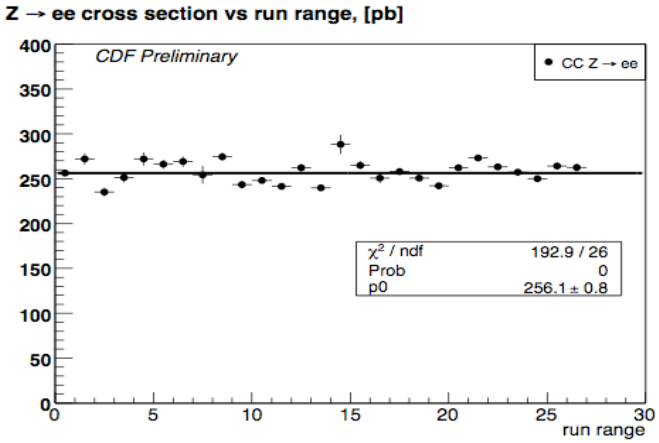
- **Electron Isolation**
  - study isolation of the $Z^0 \rightarrow e^+e^-$ electrons as function of electron E_T.
    - relative isolation goes down as $\sim 1/E_T$ (start seeing binning effect on the left-bottom plot)
    - absolute isolation stays approximately constant
  - use $E_{ISO} < 4$ GeV for all energies
- **Phoenix Charge ID**

  χ^2_{SVX} vs χ^2_{COT}

  - χ^2_{COT} of the Phoenix tracks provides the best charge ID option if used for r-phi only tracks....

ZZ resonances: status

Z→ee cross-section check



Fake Rates in 4 lepton channel: GEN7/GEN6

- expect background due to misidentified leptons to be negligible in all 3 channels
- 2 leptons + 2 jets and 2leptons + $\not\!\!E_T$ channels - use GEN6 and GEN6 ntuples
- 4 lepton channel: use GEN7 .... no GEN7 ntuples for JET* datasets
- would like to avoid a resource-intensive step of prosessing the JET* datasets with GEN7
- an alternative: use GEN6 to calculate the fake rates, derive GEN7/GEN6 scale factors

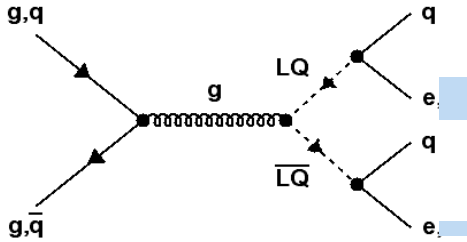
Search for first/second generation LQ

Update of the previously published analyses

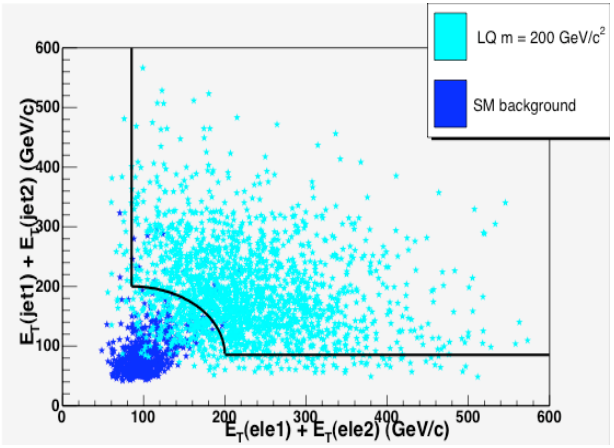
Simona Rolli (Tufts)
Gabriel Dunn (Tufts/FNAL)
Steania Vitillo (Pisa/FNAL)

Selection

- ✓ 2 leptons E_T > 20 GeV
- ✓ 2 jets, E_T(j1) > 30 GeV, E_T(j2) > 15 GeV
- ✓ Z Veto (76 < $M_{\mu\mu}$ < 110) GeV
- ✓ **Electrons/Jets: $E_T^{j1(e1)} + E_T^{j2(e2)} > 85$ GeV**
- ✓ **$((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2)^{1/2} > 200$ GeV**



SM background
Drell-Yan+2jets
Top (dilepton)
QCD/Fakes



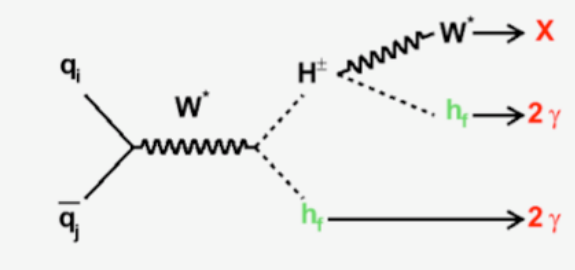
Results expected this Summer

Search for Fermiophobic Higgs into 4 γ

Atsunari Hamaguchi,
Toru Okusawa, Yoshi Seiya,
Kazuhiro Yamamoto
Osaka City University

2DHM-typeI models predict fermiophobic Higgs
The search is conducted in the channel:

$$p\bar{p} \rightarrow H^{\pm}h_f \rightarrow W^{*}h_f h_f \rightarrow 4\gamma + X$$



Selection Criteria
Event-Vertex, Geometrical & Kinematical Cut
Event-Vertex $\lvert Z_{vert}\rvert \leq 60$cm
CEM
$E_T > 15$GeV
Photon ID Cut
no track
$E_{Had}/E_{EM} < 0.055 + 0.00045 \times E$
χ^2(Strips + Wires)/2.0 < 20
Conversion Photon ID Cut
track
$E_{Had}/E_{EM} < 0.055 + 0.00045 \times E$
χ^2(Strips + Wires)/2.0 < 20
Track$-P_T < 1 + 0.05 \times E_T$
Isolation Cut
E_T>20 GeV : iso4 < 2.0+0.02×(E_T-20.0) GeV
E_T<20 GeV : iso4/E_T < 1.0

The signature is quite clean and straightforward
One important issue is still that of photon selection cuts

Several Selection cuts were tried and rejected
An isolation cut was added instead of DeltaR

Still working on background and fake rate determination

Conclusions

The VEP group is very active and producing results!!

All the analyses are constantly monitored for updates and we plan to complete and bless them all by the end of 2010

We welcome more people! There are still interesting topics that need analyzers! Come and talk to us!

Feature Presentations

Tingjun Yang - Searches for RS graviton in gamma-gamma

Benjamin Auerbach - Searches for new physics in complex final states and ttgamma cross-section

Differences with previous analysis

Several things have changed since the previous analyses

•Ntuple format - we used eN ntuples previously but the package is not maintained anymore (plus we did the ntuple skimming)
    •we are using TopNtuple now

•MC Release - our previous analysis was based on gen5 MC
    •We have regenerated the signal samples with 6.1.4mc and recalculated our signal efficiencie
    •We are also using the Top group W+jets and ttbar samples generated with 6.1.4 (alpgen samples)

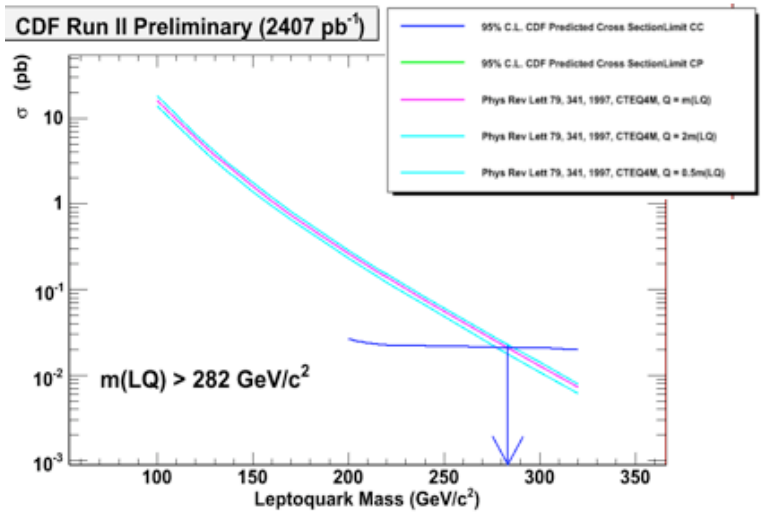
•These are the major changes, essentially in the infrastructure

Results

Preliminary limit with 2.4fb-1

- We used a rather large uncertainty on the background:
  - 50% uncertainty on the number of predicted background (consistent with the 200 pb^{-1} analysis)
  - We used bayes to calculate the limit

P8-P19



Number of observed events: 11

$\sigma_{LIMIT} = N_{LIMIT}/(\mathcal{L} \times \varepsilon \times \beta\beta)$

$\beta = 1$

Expected background 8.97± 4.0

Limit improved of ~50 GeV

13

Simona Rolli - LQ

Fermiophobic Higgs: background

The number of background events is estimated from the number of jets faking photons in 4-γ final state. The number of background events is given by:

$$N_{BG}(E_T^{\gamma}) = \int P_{jet\to\gamma}(E_T^{jet}) \times dN/dE_T^{jet} \times z(E_T^{jet}, E_T^{\gamma})\, dE_T^{jet}$$

$$= \int P_{jet\to\gamma}(E_T^{jet}) \times \frac{dN/dE_T^{jet}}{dN_{jet}/dE_T^{jet}}\, dN_{jet}/dE_T^{jet} \times z(E_T^{jet}, E_T^{\gamma})\, dE_T^{jet}$$

1) 2) 3)

1) $P_{jet\to\gamma}(E_T^{jet})$ is the E_T^{jet} dependent probability of a jet faking a photon in the diphoton sample. We measure this fake rate ($P_{jet\to\gamma}$)in the jet samples.

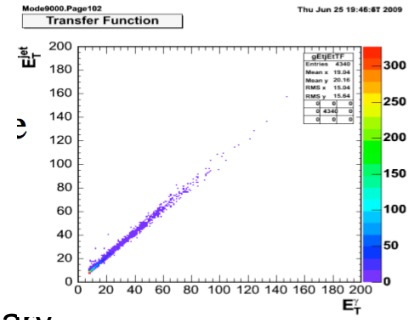
2) dN/dE_T^{jet} is the E_T^{jet} distribution in diphoton sample. dN_{jet}/dE_T^{jet} is the E_T^{jet} distribution in the jet triggered samples. We compare dN/dE_T^{jet} with dN_{jet}/dE_T^{jet} .

The term $\frac{dN/dE_T^{jet}}{dN_{jet}/dE_T^{jet}}$ cancels if the E_T^{jet} distributions are the same in the sample used to measure the fake rate.

3) $z(E_T^{jet}, E_T^{\gamma})$ is a matrix which gives the probability of a jet of E_T^{jet} to be measured as E_T^{γ}.

- We will fit to Z distributions in each E_t^{jet} (E_t^{γ})

  ($Z = E_t^{\gamma}/E_t^{jet}$)



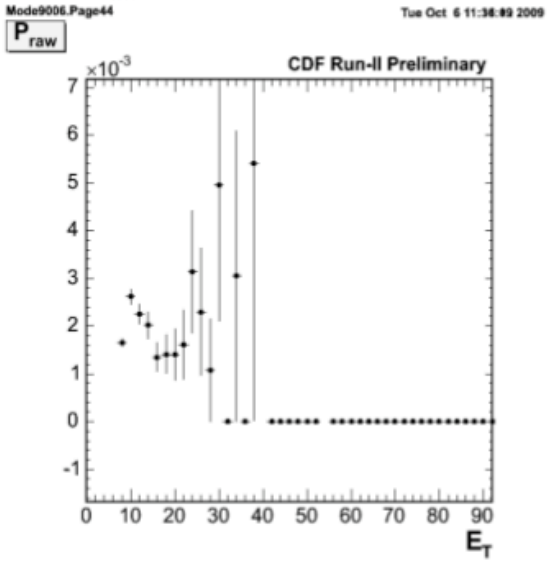
Fermiophobic Higgs:status

1)Fake probability:

$$P_{raw}(E^{jet}_T) = \frac{N_{\gamma-candidate}}{N_{jet}}$$

- N_{jet} : Number of jet , $N_{\gamma\text{-candidate}}$: Number of "γ"
- Jet requirement
  - Jet $E_T > 15GeV$
  - Jet $|\eta| < 1.1$
  - Use the $3,4,5^{th}$ ··· highest E_T Jet in an event

- P_{raw} (JET_20)



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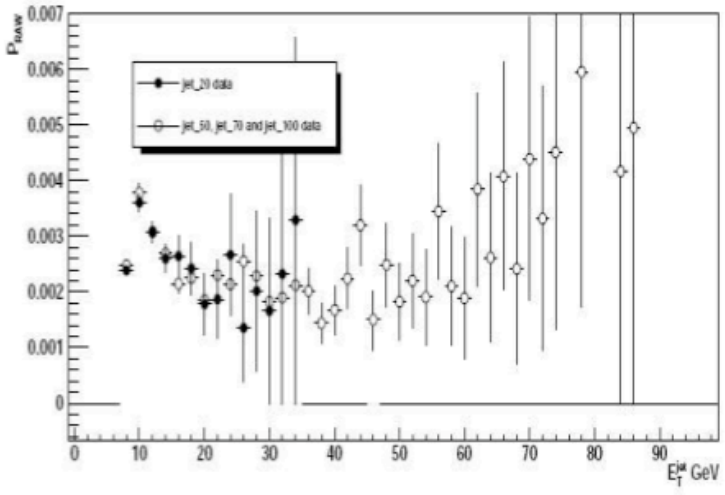

Still discrepancies with previous studies: more checks in progress